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PLASMA

Discharge between Liquid Jet and Metallic Electrodes

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Abstract—Experimental investigation of the low-temperature plasma of a gas discharge initiated in an interelectrode gap where one electrode is a liquid jet cathode and the other is a metallic anode has been carried out. Data are presented for the physical and spectral characteristics of the discharge and plasma composition. The electron concentration and temperature, as well as the vibrational and rotational temperatures of the heavy component have been estimated. The form and type of the discharge and also gas-hydrodynamic and thermal processes at the interface are described.

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INTRODUCTION

The physics and application of the electric discharge in between solid electrodes in gases have been studied at length by researchers from different scientific schools [1, 2]. Over the last two decades, these investigations have been complemented by a new line of research concerning a discharge initiated between liquid electrolyte electrodes. Discharge of this type is initiated by a constant or variable electric field in an interelectrode gap in which one or both electrodes are liquids. As liquids, distilled water or process water solutions of salts taken in different concentrations are usually used. Researches are now concentrating on the form and type of this discharge, plasma composition, plasma component concentration and distribution, physical and spectral characteristics of the discharge, gas-hydrodynamic and thermal processes in the discharge initiation zone, and construction of mathematical models of breakdown and discharge initiation. Discharges in liquid electrolytes are widely used in different branches of industry. In mechanical engineering, this type of discharge is applied in processing the outer and inner surfaces of machine parts made of different metals and alloys. In public health service, this discharge is applied for medical instrument sterilization and water and air purification. Russian [3–10] and foreign [11–14] publications in this field of research are available.

Although fundamental science has an interest in this type of discharge and it finds wide application, most works consider the case when a metallic electrode is immersed in or is over a liquid. However, the ever-increasing use of concentrated energy fluxes and processes on their basis necessitates gaining a deep insight into the physics and application of a discharge between liquid jet and metallic electrodes. Theoretically, the need for such investigations stems from the fact that many concepts of the physics of gas discharge between solid electrodes are insufficient for describing processes taking place in discharges between metallic and liquid electrodes. In this system of discharge initiation, complex nonstationary processes take place and an interplay exists between gas-hydrodynamic processes in the liquid jet and the initiation of the discharge. The features of the discharge initiation should be taken into consideration, since otherwise it is difficult to construct adequate models of nonlinear processes in the low-temperature plasma of liquid-electrode discharges. In applied research, problems must be solved such as local surface processing of parts aimed at improving the quality of the surface layer. Here, the discharge with a liquid jet electrode may be successfully used.

The purpose of this work was to experimentally study the characteristics of a discharge initiated between a liquid jet anode and a metallic cathode under atmospheric pressure. Results may be used to construct models of nonlinear processes in the low-temperature of liquid-electrode discharges.